

1996

Death due to injury in Quito, Ecuador

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Eric Sean Steenlage

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Death Due to Injury in Quito, Ecuador

A Thesis Submitted to the
Yale University School of Medicine
in Partial Fulfillment of the Requirements for the
Degree of Doctor of Medicine

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DEATH DUE TO INJURY IN QUITO, ECUADOR

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Trauma is the leading cause of death in Quito, Ecuador (population 1.5 million). Our objective was to determine Quito's need for pre-hospital trauma transport systems. Two methods were used. The first was collection of transport times and outcome data from trauma victims with splenic injuries treated at two hospitals (one urban, one rural) in the United States over a two-year period. This information was compared to data from a similar population in Quito. The second method was examination of autopsy reports from trauma victims dying in Quito in 1994. Results from the splenic study were inconclusive. There were 69 splenic injuries with 14 deaths, none due to the splenic injury, at the urban US hospital, and 39 splenic injuries with 4 deaths, one due to delayed presentation of the splenic injury, at the rural hospital. Surprisingly, there were only 5 patients with documented splenic injuries at the Quito hospital during a 6 year period. Analysis of autopsy data revealed an annual (1994) trauma death rate of 66.3/100,000 for Quito (US: 37.0/100,000), with 64% sustaining head injuries, 30% thoracic injuries, and 30% abdominal injuries. Only 28% of the trauma victims who died in Quito received medical attention before death. There were 39.1/100,000 motor vehicle-related deaths in Quito (US: 18.8/100,000). Pedestrian injuries were the largest single category of trauma deaths in the city, representing 53% of all motor vehicle-related deaths (US: 15%); there were 20.9/100,000 pedestrian deaths in Quito (US: 2.7/100,000). Trauma is an excessive cause of mortality in Quito. Major factors contributing to this are the small percentage of trauma victims receiving medical attention prior to death and the high incidence of auto-pedestrian injuries. Injury prevention measures and adequate pre-hospital provider systems are desperately needed in Quito.

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Death Due to Injury in Quito, Ecuador

Introduction

Trauma has become the leading cause of death in Quito, the capital of Ecuador.⁹ The second-leading cause of death in Ecuador as a whole,⁷ death due to injury is a growing problem in almost all areas of the world. It has been estimated that 7-8% of all deaths worldwide are due to injury and violence.¹ In addition, the World Health Organization estimates that each year, 2% of the world population is disabled due to injuries sustained from external causes.² Premature death from injuries sustained through accidents or violence accounts for 15.3% of all years of potential life lost in males and 8.2% in females, worldwide.³ In addition to the many lives lost and individuals disabled due to injuries from external causes, the economic cost of treating these patients is monumental. The World Health Organization estimates that in 1989 almost one-third of all hospital admissions in the world were due to injury.⁵ The social and medical costs of treating these injuries exceeded \$500 million worldwide; the cost of treating people injured in transportation accidents alone amounted to nearly 1% of the GDP (Gross Domestic Product) in many developing countries.⁵ In the United States, injury is the leading cause of potential years of life lost prior to the age of 70; annually, there are 4.3 million potential years of life lost prematurely due to injuries, compared to less than 3 million each for cancer and cardiovascular disease.⁴

Trauma is a greater problem in developing countries than it is in industrialized nations. Of the total number of years of potential life lost from people dying prematurely, and of the total number of people suffering disabilities from all causes, injuries account for 20.5% for males (8.1% for females) in Latin America and the Caribbean. This compares to 15.3% and 8.2% for males and females, respectively, worldwide.³ In 1988, 7.1% of all deaths from defined causes in the United States were due to injuries (external causes);⁶ this figure

has changed little since 1960, when 7.2% of all deaths were due to injury. In contrast, 14.5% of all deaths from defined causes in 1988 were due to injuries in Ecuador, the country which was the focus of our study,⁶ as compared to only 6.2% in 1960.

By 1990 injury ranked second among all defined causes of death in Ecuador.⁷ Injuries were the leading cause of death from defined causes in the population aged 5 to 44.⁷ The single largest category of injury deaths were those that were a consequence of motor vehicle traffic crashes. Of the 5,043 registered deaths from injuries in Ecuador in 1990, motor vehicle traffic crashes represented 40.6% of the total.⁷ Motor vehicle traffic crashes alone were the fourth largest cause of death overall in Ecuador in 1989, resulting in 18.6 deaths per 100,000 people;⁸ this rate has been steadily increasing. In 1990, there were 555 registered deaths from motor vehicle crashes per 100,000 vehicles in Ecuador; this rate is the highest of any country in North or South America and compares to a rate of 25 registered deaths from motor vehicle crashes per 100,000 vehicles in the United States.⁷

Death due to injury, particularly motor vehicle traffic crashes, appears to be an even greater problem in Quito, Ecuador's second largest city (pop. 1,500,000), than in the rest of the country. By 1987 motor vehicle traffic crashes alone had replaced infectious disease as the largest single cause of death in Quito, resulting in 25.7 deaths per 100,000 people.⁹

Several factors are thought to contribute to this excessively large cause of death in Quito. One of these factors is thought to be the lack of an adequate emergency transport system for trauma victims in the city. Eight major hospitals provide health care for Quito's population, but none of these hospitals have developed an appropriate emergency transport system.

It has long been recognized that rapid treatment following traumatic injury substantially increases the patient's chance of survival.^{25, 26} Rapid transport via emergency transport systems from the scene of the injury to a medical treatment facility is therefore critical for

seriously injured trauma victims. The lack of any organized emergency transport within Quito has undoubtedly lead to lengthy transport times from the site of injury to the treating hospital. To our knowledge, no formal studies of transport times in Quito have been done, but average transport times have been estimated by some physicians in Quito to be as long as 19 hours.

Knowing that trauma is the leading cause of mortality in Quito, and knowing that transport times for trauma victims are often very lengthy due to the lack of organized emergency transport systems in the city, we hypothesized that delayed or unavailable pre-hospital treatment and transport of trauma victims is contributing to injuries causing an excessive number of preventable deaths in Quito. We focused our research efforts in two different areas in order to determine whether or not our hypothesis was correct .

The first part of our study focused on comparing mortality due to splenic trauma at a hospital in Quito with that of an urban and a rural trauma center in the United States. We decided to study injuries to the spleen (the most commonly injured organ in blunt abdominal trauma¹⁰) because mortality in untreated victims of splenic trauma is high, while mortality in victims treated promptly is low.¹⁰ Treatment of even severe splenic injuries is relatively simple for a qualified surgeon with an adequate operating facility and staff, and is usually successful.^{13, 14, 15, 16} Since all of the institutions involved in our study were fully capable, given the opportunity, of definitively treating patients with splenic injuries, we theorized that any differences in mortality in patients with similar injuries would most likely be due to differences in transport times. Our objectives were to: 1) determine whether or not there was a difference in mortality in trauma victims with similar splenic injuries in the two countries; 2) determine if there was a significant difference in transport time following the injury; and 3) determine if the increased mortality in Quito, Ecuador could be correlated to the longer transport times.

The second part of our study focused on a review of autopsy data for the city of Quito. Our primary purpose here was to determine the percentage of trauma victims in the city who received any type of medical attention, pre-hospital or otherwise, before dying. In addition to other parameters, we also documented mechanisms of injury as well as the various types of injuries incurred in order to determine if there were an excessive number of trauma deaths due to preventable causes.

Statement of Purpose

The ultimate goals of both parts of our study were to: 1) increase the recognition of the excessively high mortality rate caused by injury in Quito; and 2) determine the need for the development of pre-hospital systems that would provide adequate transport and treatment of trauma victims in Quito. If our results conclusively linked inadequate pre-hospital treatment and transport with the excessive mortality due to trauma within the city, we hoped to use this information to demonstrate the need for the development of an improved pre-hospital care system for trauma victims in Quito, Ecuador.



Methods

Part One

Our study of patients with traumatic splenic injuries was primarily designed to: 1) quantify the transport time (time of injury to time of emergency room admission); 2) document the mechanism, severity, and treatment of the splenic injury; 3) document whether the patient ultimately survived; and, if not, 4) determine if the splenic injury caused the patients demise. A number of other variables were also documented, including the patient's age, sex, admission vital signs and Glasgow Coma Score (GCS), number of days spent in the hospital, type and severity of associated injuries, etc.. A complete list of all variables collected is found in Table 1. Identical data were collected from three hospitals: two in the United States which would be used as a comparison standard for the results from the third hospital in Quito. Data collection from the two United States hospitals studied was completed prior to the collection of any data from Ecuador.

Table 1. Splenic Study Variables.

•Hospital	•Outcome (death/discharge)	•Splenic injury description
•Patient name	•Time of death	•Spleen AIS score
•Record number	•Date of death/discharge	•Splenic procedure
•Admission date	•Cause of death	•CNS injury: Y/N
•Injury date	•Age	•Thoracic injury: Y/N
•Time of injury	•Sex	•Orthopaedic injury: Y/N
•Time of field treatment	•Mechanism of injury	•Other abdomen injury: Y/N
•ED admission time	•Days on ventilator	•Assoc. injury descriptions
•Trauma center time	•Days in hospital	•Patient ISS score
•Total transport time	•Admission blood pressure	•Complications
•Date of operation	•Admission respiration rate	
•Time of operation	•Admission GCS	

The first of the United States hospitals studied, Gundersen Lutheran Medical Center in La Crosse, Wisconsin, is a large referral center for a predominantly rural region. The second, Yale-New Haven Hospital in New Haven, Connecticut, serves as the primary trauma center for a large urban and suburban area. These two hospitals were selected to give a combined rural/urban database to be used as a comparison for the Ecuadorian data. The third hospital studied, Hospital Voz Andes in Quito, Ecuador is one of eight hospitals within the city. This hospital was selected because it serves as the primary trauma treatment center for a large percentage of the city's population and, more importantly, because its record-keeping systems are better than most of the other hospitals within the city. Data from all hospitals were recorded on prepared data forms and later transferred to a computer database.

-Gundersen Lutheran Medical Center

Data collection at the first hospital studied, Gundersen Lutheran Medical Center in La Crosse, Wisconsin was completed during the summer of 1992. Gundersen Clinic, a private clinic with approximately 300 physicians, is associated with Lutheran Hospital, a 402-bed facility. This medical center is the primary trauma treatment facility for over 510,000 people in a large, 19 county, rural region in the tri-state area surrounding La Crosse, a city of approximately fifty thousand people. Annually, approximately 1,000 trauma patients are treated through this medical center's Level II Trauma Center. About one-third of these patients are initially evaluated at smaller hospitals in outlying towns before being transferred to the Gundersen Lutheran's Trauma Center via ambulance or helicopter. Records of all trauma patients treated at this facility over a two year period were retrospectively reviewed. Any patient with a documented splenic injury resulting from trauma within the two-year time period was included in the study. We collected data on a total of 39 patients.

-Yale-New Haven Hospital

Data collection at the second hospital, Yale-New Haven Hospital in New Haven, Connecticut was completed in the fall of 1994. Yale-New Haven Hospital is a 900-bed facility with 1,600 physicians. This medical center serves as the primary trauma treatment facility for 650,000 people in and surrounding New Haven, a city of approximately 125,000, and serves as a referral center for Connecticut and surrounding areas. Annually, approximately 950 injured patients are treated through this medical center's Level I Trauma Center. Most of these patients receive their initial assessment and treatment at Yale-New Haven Hospital. Records of all trauma patients treated at this facility over a two year period were reviewed retrospectively. Any patient with a documented splenic injury resulting from trauma was included in the study, for a total of 64 patients.

-Hospital Voz Andes

Data collection at the third hospital, Hospital Voz Andes in Quito, Ecuador, was completed through a Wilbur G. Down's Travel Research Fellowship in the spring of 1995. Hospital Voz Andes is a 45 bed facility, one of 8 hospitals in the city of Quito. This hospital, operated by an inter-denominational religious organization, serves as a primary trauma center for a large part of the city and as a referral center for patients turned away from other hospitals due to lack of financial resources. Their emergency room receives approximately 90 multiple trauma patients classified as "severely injured" per year. Records of 521 trauma patients consecutively treated over a six year period ending in December, 1994 were reviewed (a longer time period was used due to the smaller volume of patients). Of these patients, only five were found to have documented splenic injuries. A cohort of five patients was considered to be of inadequate size to be used as the basis for a scientifically-sound comparison study. For this reason, we decided to examine available autopsy data in Quito.

Part Two

At the Police Hospital in Quito, autopsies are reportedly done on all people who died in the city from traumatic injury or other unnatural causes. The reports are typed and filed according to date. Variables recorded in the autopsy reports include sex, age, types of injuries sustained, cause of death or mechanism of injury, and whether they received medical attention prior to death. The reports are usually very brief, rarely longer than one page. The severity of the particular injuries of the trauma victims is not consistently documented, making it difficult to determine what role each injury played in the patient's death. For example, there were numerous patients with recorded cranio-facial fractures; while there was undoubtedly a full spectrum of these injuries with various degrees of severity, this differentiation was rarely recorded. Regardless, compilation of any of the information contained in the autopsy reports had, to our knowledge, never been done. At this point, the focus of our project shifted from studying only patients with splenic injuries to compiling data from autopsy reports (for a one-year time period). All variables recorded are listed in Table 2.

Table 2. Autopsy Study Variables.

•Date of autopsy	•Blood alcohol test sent: Y/N
•Sex	•Medical attention prior to death: Y/N
•Age	•Blood alcohol test results (2 months)
•Types of Injuries	•Blood alcohol level (2 months)
•Cause/mechanism of death	

Autopsy reports from all individuals dying in Quito of unnatural causes in 1994 (1,272 people) were reviewed. Each type of injury and cause of death recorded was given a numerical code; these and all other variables studied were entered into a computer

spreadsheet program (Microsoft Excel™, on a Macintosh Powerbook 165™). The data were then analyzed using a statistical analysis program (Systat™). Though a departure from our original study, we hoped this data would satisfy our original objectives: 1) increase the recognition of the excessively high mortality rate caused by injury events in Ecuador; and 2) determine the need for the development of pre-hospital systems to provide adequate transport and treatment of trauma victims in Quito.

Results

Part One

-Gundersen Lutheran Medical Center

Of all trauma patients treated at Gundersen Lutheran during the two-year period studied, 39 had splenic injuries documented either by CT-scan or intra-operatively. The splenic injuries were graded using the AIS (Abbreviated Injury Score) scaling system, giving the injuries a rating from one to five, five representing the most severe injuries. The average injury grade was 2.9. Fifty-four percent of these patients were treated non-operatively, 8% by surgically repairing the splenic injury, 28% underwent splenectomy, and 10% had a laparotomy but had no procedures performed on the spleen. Four patients died; only one of these deaths was caused by the splenic injury. The other three deaths resulted from more serious injuries to other organ systems; the patients who died had an average splenic AIS score of 2.8. The single death resulting from a splenic injury was the result of a delayed splenic rupture occurring approximately one week after the initial injury (the splenic injury was not initially diagnosed). Time of injury and transport time had been documented for 34 (87%) of the patients; they ranged from 27 minutes to one week in the patient with the delayed splenic rupture. Of the patients with documented transport times, 68% arrived at the hospital within three hours of sustaining their injury.

-Yale-New Haven Hospital

Of all trauma patients treated at Yale-New Haven Hospital during the same two year period, 64 had splenic injuries documented either by CT-scan or intra-operatively. The average AIS splenic injury grade was 3.0. Fifty-one percent of these patients were treated non-operatively, 11% had their splenic injury surgically repaired, 27% underwent splenectomy, and 11% had a laparotomy but had no procedures performed on the spleen. Fourteen patients died; none of these deaths were caused by the injury to the spleen. All 14 deaths resulted from more serious injuries to other organ systems; these patients had average

splenic AIS score of 4.3. Time of injury and transport times had been documented for 23 (36%) of the patients; they ranged from 17 minutes to 31 hours in a patient with delayed symptoms. Of the patients with documented transport times, 83% arrived at the hospital within three hours of sustaining their injury.

-Hospital Voz Andes

Of the 521 "poly-trauma" patients treated at the Hospital Voz Andes during the six-year period studied, only five had documented splenic injuries; all were diagnosed intra-operatively. The average AIS injury grade was 3.8. None of these patients were treated non-operatively. One of the five patients had the splenic injury repaired; the other four underwent splenectomy. None of the five patients died. Transport times were documented for all five patients; they ranged from 30 minutes to two hours and 35 minutes.

Part Two

-Hospital Policia

Reports of all autopsies done at the Police Hospital morgue during the calendar year 1994 were reviewed, for a total of 1,272 autopsy reports. Only 344 (27%) of the 1,272 people autopsied received any type of medical attention (pre-hospital or otherwise) prior to death. Of the total 1,272 deaths, 995 (78%) were determined to result from traumatic external causes; all the various mechanisms of injury included in this category are listed in Table 3. This subset of 995 trauma victims will subsequently be referred to as "trauma deaths". All further data analysis applies only to this group of 995 people. Of the 995 trauma victims, 777 (78%) were male; 218 (22%) were female. Five-hundred and eighty-two (59%) were between the ages of 20-49; a complete breakdown of age is shown in Table 4.

Table 3. Mechanisms of injury listed as cause of death in Quito in 1994.

Mechanism of injury	Number of Deaths	Percentage of Total
Pedestrian	313	31%
Motor vehicle crash	158	16%
Motor vehicle roll-over	102	10%
Shot	96	10%
Fall	95	10%
Stab	62	6%
Cranio/facial trauma	43	4%
Suffocation	33	3%
Trauma (unspecified)	25	3%
Electrical burn	18	2%
Drowning	13	1%
Fall from moving vehicle	11	1%
Buried (accidental)	8	0.8%
Traumatic hemorrhage	7	0.7%
Burn	3	0.3%
Explosion	3	0.3%
Crush	3	0.3%
Crush (by motor vehicle)	2	0.2%

Table 4. Number of people dying due to injury by decade of life in Quito in 1994.

Age	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Deaths	81	108	243	198	141	87	57	49	24	2
Percent	8%	11%	25%	20%	14%	9%	6%	5%	2%	0.2%

Only 278 (28%) of the 995 people dying as a result of injury received medical attention of any type prior to death. The number of deaths attributed to the various mechanisms of injury is listed in Table 3. Mechanisms of injury were grouped into eight categories, as illustrated in Table 5. One third (31%) of the total number of trauma deaths were due to injuries sustained by pedestrians, and nearly another third (27%) were due to other motor vehicle-related injuries. A complete breakdown of the number of deaths in each category is listed in Table 5 and illustrated in Figure 1. The percentage of people in each category who received medical attention is also listed in Table 5.

Table 5. Categories of injury mechanisms; number of deaths in each category; number receiving medical attention (% per mechanism category); and number incurring head, thoracic, or abdominal injuries (% per mechanism category)^b.

Mechanism ^a	Deaths (% of total)	Medical attn.	Head inj.	Thoracic inj.	Abdom. inj.
Pedestrian	313 (31%)	93 (30%)	236 (75%)	99 (32%)	113 (36%)
MVC	273 (27%)	72 (26%)	195 (71%)	104 (38%)	117 (43%)
Penetrating	158 (16%)	32 (20%)	57 (36%)	73 (46%)	37 (23%)
Fall	95 (10%)	36 (38%)	83 (87%)	18 (19%)	15 (16%)
Unspecified	75 (8%)	30 (40%)	56 (75%)	6 (8%)	5 (7%)
Suffocation	44 (4%)	4 (9%)	1 (2%)	1 (2%)	2 (6%)
Burn	21 (2%)	10 (48%)	1 (5%)	0	0
Misc.	16 (2%)	1(6%)	3 (19%)	1 (6%)	1 (6%)

^aCategory 1: Pedestrian

Category 2: Motor vehicle crashes (not including pedestrians)

Category 3: Penetrating injuries (gunshot/ stab)

Category 4: Falls

Category 5: "Trauma" deaths (no further mechanism specified)

Category 6: Suffocation, burial, or crushing injuries

Category 7: Burn injuries

Category 8: Miscellaneous (drowning or explosion)

^bPercentage totals for all types of injuries may be greater than 100% as some patients sustained more than one type of injury.

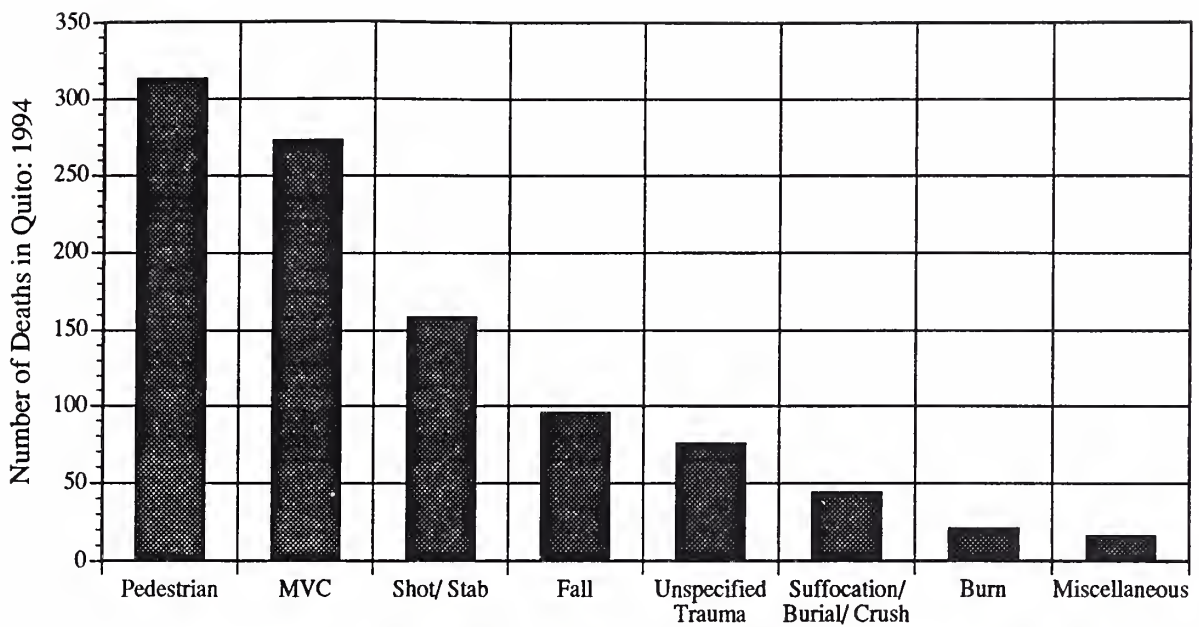


Figure 1. Mechanisms of Injury Causing Death in Quito: 1994

Pedestrian injuries were the most frequent cause of death for every decade of life except for people aged 20-39. Motor vehicle crashes were the primary cause of injury in the 20-39 age group and the second most frequent cause in all other decades of life, the only exception being the 10-19 age group in which shootings or stabbings were the second most common mechanism of injury. The most frequent mechanism of injury for each decade of life is illustrated in Figure 2.

-Types of Injuries

Of the 995 total trauma deaths, approximately two-thirds (64%) sustained some type of head injury, a third (30%) had thoracic injuries, and a third (30%) had abdominal injuries. Of the 313 pedestrian deaths, three-fourths (75%) sustained head injuries, a third (32%) sustained thoracic injuries, and a third (36%) had abdominal injuries. The 273 people dying in motor vehicle crashes sustained a similar distribution of injuries. Of the 158 shooting or stabbing victims, a third (36%) were wounded in the head, nearly half (46%) in the thoracic area, and a fourth (23%) in the abdomen. A complete breakdown of the

number of people in each category who had head, thoracic, or abdominal injuries is listed in Table 5.

Figure 2. Most frequent mechanism of injury for each decade of life: Quito, 1994.

Rank	Age									
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
1	Pedest.	Pedest.	MVC	MVC	Pedest.	Pedest.	Pedest.	Pedest.	Pedest.	Fall
2	MVC	Penetrat.	Pedest.	Pedest.	MVC	MVC	MVC	MVC	Fall	Suffocat.
3	Suffocat.	MVC	Penetrat.	Penetrat.	Penetrat.	Penetrat.	Fall	Fall	MVC	Pedest.
4	Fall	Fall	Unspec.	Unspec.	Fall	Fall	Unspec.	Unspec.	Unspec.	MVC
5	Unspec.	Suffocat.	Fall	Fall	Unspec.	Unspec.	Penetrat.	Suffocat.	Suffocat.	Penetrat.
6	Burn	Burn	Suffocat.	Suffocat.	Suffocat.	Suffocat.	Suffocat.	Penetrat.	Penetrat.	Unspec.
7	Misc.	Misc.	Burn	Burn	Misc.	Misc.	Burn	Burn	Burn	Burn
8	Penetrat.	Unspec.	Misc.	Misc.	Burn	Burn	Misc.	Misc.	Misc.	Misc.

-Splenic Injuries

Seventy-three (7%) of the 995 trauma victims had a documented splenic injury; 72 out of the 73 had other associated injuries. There were 34 splenic injuries (47% of the total) sustained in both the pedestrian and the MVC categories. The remaining five splenic injuries resulted from injury mechanisms in four other categories. Only eight of the 73 trauma victims with splenic injuries (11%) received any medical attention prior to death.

-Blood-Alcohol Tests

The results of the blood-alcohol-level tests done on the 162 people who died during the last two months of 1994 were compiled. Of these 162 people, 118 had a blood sample submitted for blood-alcohol testing. Test results were available for 108 of the 118 blood samples submitted. Of these 108 blood samples, 40 (37%) had detectable alcohol levels.

Discussion

Part One

Trauma has become the leading cause of death in Quito, Ecuador. Many factors contribute to this, one of which is the city's nearly complete lack of an organized emergency transport system. The majority of the injuries incurred in the city are due to blunt trauma. Although it has been determined that the spleen is the most commonly injured intra-abdominal organ in blunt trauma victims,¹⁰ death due to splenic injury is very uncommon in the United States and the rest of the Western world.¹⁰ Treated promptly, splenic injuries are rarely a cause of death.¹⁰ Rapid treatment is therefore essential, as the severe internal bleeding associated with major splenic injuries can cause the patient to exsanguinate.

Although loss of the spleen increases the patients risk for overwhelming post-splenectomy infection,^{11, 12, 13} the spleen itself is not an essential organ needed by the body for day to day existence.^{13, 14, 15} This knowledge has led to splenectomy becoming the treatment of choice for severe splenic injuries,^{13, 14, 15, 16} with splenorrhaphy the preferred treatment for mild to moderate splenic injuries.^{14, 15, 17, 18} Splenectomy has the benefit of being a relatively simple operation, capable of being undertaken by nearly any general surgeon in a hospital with basic operating room facilities and staff.

Since definitive treatment of splenic injuries is relatively simple and usually successful, rapid transport from the site of injury to the treatment facility is often the key determinant to the patients survival. While hospitals in Quito, Ecuador, are often not as well equipped or as modern as their United States counterparts, they all appear more than capable of permitting the performance of splenectomies and definitively treating splenic injuries. We hypothesized, therefore, that differences in mortality among patients with splenic injuries may primarily be due to differences in transport times in the two countries. Our purpose

was to determine if there was a difference in mortality due to similar injuries in the three hospital systems, and to determine if mortality could be correlated to transport time.

-Gundersen Lutheran Medical Center/ Yale-New Haven Hospital

The two hospitals in the United States used as comparisons for the Ecuadorian hospitals were chosen because they provide health care for two very different populations, each of which poses different challenges for their respective emergency transport systems.

Together, they provide a broad trauma transport database for use as comparison standard for the Ecuadorian data. The first United States hospital, Gundersen Lutheran Medical Center in La Crosse, Wisconsin is the primary trauma treatment facility for a large, primarily rural population. The large geographic area served by this medical center, as well as the remote, isolated location of many of the injury sites, pose special challenges to efforts to rapidly transport trauma victims. These challenges have been largely overcome by using local First Responder emergency treatment teams, use of smaller regional hospitals as initial stabilization centers, and use of helicopter ambulances for rapid air transport.

The second United States hospital studied, Yale-New Haven Hospital in Connecticut, provides care for a very different, primarily urban population. While serving a geographically smaller area, the larger population poses a different but no less challenging set of problems for efforts to rapidly transport trauma victims. Both of these hospital systems have developed coordinated emergency transport systems, designed to overcome the problems posed by the different populations they serve, that provide rapid field treatment and transport for injury victims. This is illustrated by the fact that, with one exception, none of the patients at either institution in our study died as a result of their potentially life-threatening splenic injury. The single death due to an injury to the spleen was in a patient who presented with a delayed splenic rupture one week after he was

injured. All of the other patients in the study who died with splenic injuries had another injury that was determined to be the primary cause of death. While time of injury (and therefore, transport times) were not documented for many of the American patients in the study, the virtual lack of any mortality due to splenic injury at either United States institution suggests that transport time did not contribute to preventable deaths due to splenic trauma at these two medical centers.

-Hospital Voz Andes

There were no documented deaths due to splenic injuries at the Hospital Voz Andes in Quito, either. However, the very small number of patients with documented splenic injuries (five over a six year period) at this hospital makes it difficult to draw conclusions from these data. The small study population also raises the question of why there were so few patients with splenic injuries seen at Hospital Voz Andes. Although considerably smaller than either of the United States hospitals studied, Hospital Voz Andes provides emergency care for a large part of the population of Quito, a city with a very high volume of trauma patients each year. Despite the large number of trauma victims in the city, organized emergency transport is virtually non-existent in Quito. The few ambulances that do exist are operated by private hospitals on a fee-for-service basis, preventing them from being used by a large proportion of Quito's population. The ambulances, with few exceptions, are staffed only by the drivers; there are no emergency medical technicians and no treatment is performed in the field. Of the trauma patients treated at Hospital Voz Andes (located in the wealthier half of the city) over a six year period, 11.5% arrived by ambulance, but the majority (56%) arrived by car (often police car) or taxi. It is unlikely that these statistics are significantly different for any of the other seven major hospitals in the city, with the possible exception of the military hospital, where many patients arrive by military transport. The state-run hospitals serving the large indigent population most likely have an even smaller percentage of patients arriving by ambulance. While this overall lack

of adequate emergency transport has undoubtedly led to lengthy transport times, the lack of organized emergency medical systems has also made transport time data very difficult to document or study.

The data collected from our study of splenic injuries were not sufficient to either prove or disprove our original hypothesis that delayed or unavailable pre-hospital treatment and transport of trauma victims has contributed to injuries causing an excessive number of preventable deaths in Quito. In retrospect, the spleen was probably not the best organ system to study in order to determine the impact of delayed transport on trauma victims in Quito. The likely reasons for so few patients with documented splenic injuries at Hospital Voz Andes were thought to be: 1) the likelihood that there were a significant number of trauma victims with splenic injuries who did not survive long enough to reach the hospital; 2) the lack of sophisticated diagnostic equipment (CT scanners) available to aid in the diagnosis of less severe splenic injuries; and 3) the smaller patient volume at the Quito hospital. Regardless of the reason, the small number of patients with documented splenic injuries at Hospital Voz Andes made it impossible for us to definitively determine if there was any correlation between transport times and mortality.

Part Two

Unable to study a basically non-quantifiable variable (i.e. transport time) in Quito, we shifted the focus of our study to a review of the trauma deaths within the city. We attempted to identify the number of trauma victims who died with an injury to the spleen during a one-year period, determine if the splenic injury was the primary cause of the patient's demise, and document whether the victim received any type of medical attention prior to death. If a large number of the people dying from splenic injuries had received no medical attention before dying, we theorized that a significant proportion of these deaths may be due to the difficulties associated with providing rapid emergency transport in Quito.

-Hospital Policia

Autopsies are reportedly performed at the Hospital Policia (Police Hospital) on all victims of unnatural death within the city. In certain cases autopsies may be done at other hospitals, but the vast majority are performed at the Hospital Policia. Although all the reports are typed and filed according to date, no compilation of the information contained in the reports was available. This made it impossible to select the autopsy records for only those trauma victims who died with splenic injuries. However, we also recognized that the autopsy reports contained much information that, if compiled, could prove very useful in identifying such parameters as the most frequent mechanism of injury in Quito, most common type of injury incurred, percentage of trauma victims receiving medical attention, etc.. Such information, while very basic, is crucial in determining what types of trauma prevention or treatment measures are most desperately needed.

Our main objectives in studying the autopsy data were to determine the percentage of trauma victims receiving medical attention before dying and to document the most common mechanisms of injury. For the victims who received no medical attention, it was nearly impossible to determine the exact number who may have survived had they received medical attention, given the brevity of the injury descriptions contained in the autopsy reports. Intuitively, however, absence of medical attention would contribute to an increased mortality rate for any population of trauma victims. A large number of people dying as a result of injury, without receiving medical attention, would support our original theory that inadequate pre-hospital medical care is contributing to injuries causing an excessive number of preventable deaths in Quito.

-Trauma Statistics

The compiled 1994 autopsy statistics for Quito identify several points that bear discussion. The 995 injury deaths equal a rate of 66.3 deaths due to injury per 100,000 people in Quito; this is dramatically higher than the rate of 37.0 deaths per 100,000 due to "accidents and adverse effects" for the United States population.¹⁹ Our most significant finding was discovering that, of the 995 people dying from an injury in 1994, barely one-fourth (28%) received any type of medical attention before dying. While it is impossible to determine exactly how many of the other 72% may have survived if they had received medical attention, a significant number of them undoubtedly would have lived. While often difficult to determine the exact severity of each injury from the brief autopsy reports, it was clear that many of the trauma victims died from relatively minor injuries that they probably would have survived had emergency medical transport and treatment been available.

The number of deaths due to motor vehicle crashes and traffic accidents is also significant. In Quito in 1987, there were 25.7 deaths due to motor vehicle traffic accidents per 100,000 people.⁹ In 1994, the 586 deaths due to motor vehicle crashes and pedestrians being hit by motor vehicles translates into 39.1 deaths due to motor vehicle traffic accidents per 100,000 people (assuming Quito's population to be 1.5 million people). This rate is markedly higher than that found in the United States, where the Bureau of the Census has reported a rate of 18.8 deaths due to motor vehicle-related trauma per 100,000 people.¹⁹ The increase in deaths due to motor vehicle-related injury in Quito from 25.7 deaths/100,000 people in 1987⁹ to 39.1 deaths/100,000 people in 1994 illustrates the growing severity of this problem.

Figure 3 illustrates the death rate for trauma deaths in several categories in the United States and Quito; the distribution is markedly different, particularly for pedestrian injuries. These differences would most likely be even more striking if the Quito data were compared to

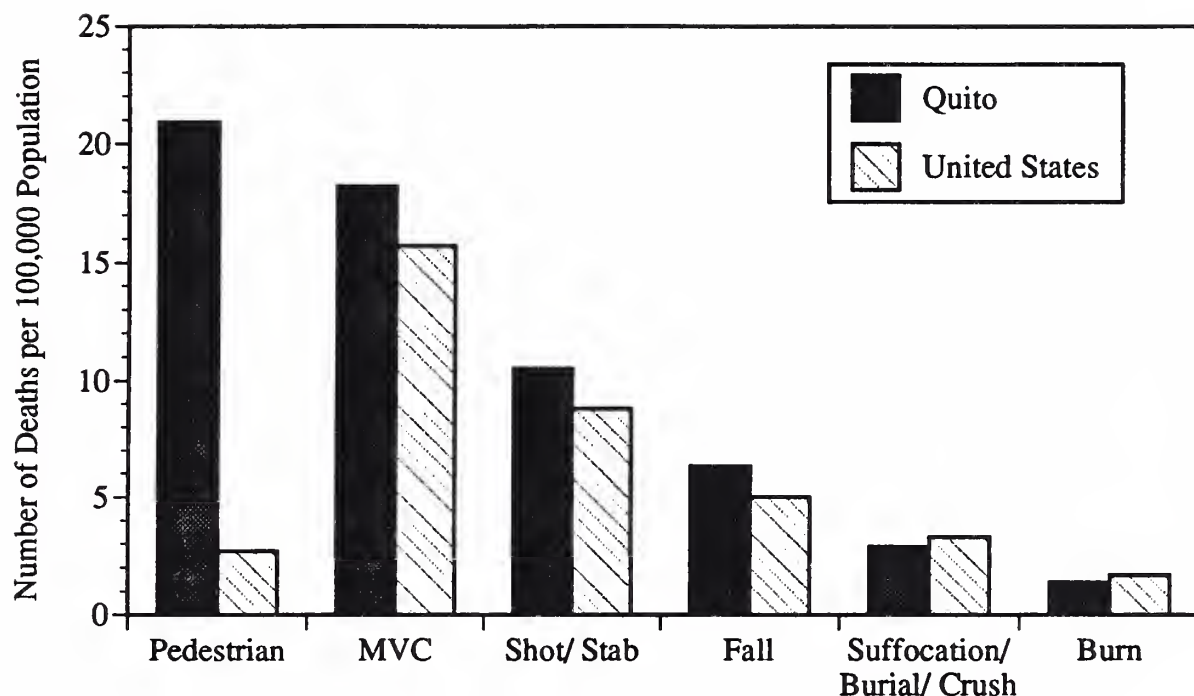


Figure 3. Death Rates per Category of Injury Mechanism

United States data from urban areas alone, as the death rate from motor vehicle related-injuries in most rural areas is more than 50% greater than that for urban areas.⁴ Also, the death totals in Quito may well be even higher than we have reported, given that a significant amount of under-reporting of the number of deaths is probable.

Pedestrian deaths alone have become the leading cause of trauma death in Quito (Figures 1 and 3), representing nearly a third of the total number of 1994 injury deaths. The death rate in Quito for pedestrian injuries alone, 20.9 deaths/100,000 people, is higher than the death rate for all motor vehicle-related trauma, combined, in the United States, and compares to a pedestrian death rate of 2.7/100,000 population in United States.¹⁹ Over half (53%) of all motor vehicle-related deaths are due to pedestrian injuries in Quito, while only 15% of all motor vehicle-related deaths are due to pedestrian injuries in the United States.¹⁹ The disproportionate number of pedestrian deaths in Quito make it the patient population that would probably most benefit from mortality-reduction efforts.

Of the 73 trauma victims dying with documented splenic injuries, only eight (11%) received any medical attention before dying. While many of the 73 had associated injuries that were probably more severe than their splenic injury, some of them did not. Many had relatively minor associated injuries, or, in one case, no other associated injuries; the splenic injury was the likely cause of death in these individuals. Given the previously discussed success rate for treating splenic injuries, many of these 73 deaths were probably preventable had rapid transport and treatment been available.

-Need for Injury Prevention

Our study clearly demonstrates that there is a serious lack of adequate pre-hospital care and emergency transport facilities in Quito; other studies of trauma care systems in developing countries have come to similar conclusions.²⁰ Despite the glaring need for the development of transport systems for trauma victims in Quito, this change alone would not completely resolve all of the factors contributing to the excessively high number of trauma deaths within the city. Prevention of injury is always preferable to treatment, regardless of the efficacy of the pre-hospital treatment and emergency transport systems. Previous studies have estimated that approximately 50% of trauma deaths occur within minutes of injury;^{21, 22} efforts at prevention and reduction of injury are the only hope of reducing mortality in this group. Most immediate trauma deaths are due to central nervous system injury,^{21, 22} and 64% of the trauma victims in our autopsy study had some type of head injury which was the likely cause of death for many of them. The number of trauma victims with head injuries was highest (75%) for those injured in pedestrian accidents, and second highest (71%) for those injured in motor vehicle crashes (Table 5). Pedestrian injuries and motor vehicle crashes were the first and second largest single categories of injury, respectively, together representing 58% of the total number of trauma deaths in Quito. With nearly three-fourths of this 58% suffering some type of serious head injury, this group alone

represents a large patient population (nearly half of the total number of trauma deaths) in which prevention of injury may be the only effective way of reducing mortality, regardless of the availability of emergency transport.

The evaluation of potential injury prevention strategies needs to be the first step in any effort to reduce the excessive number of motor vehicle-related fatalities in Quito. As in the United States,⁴ and despite the large number of deaths due to trauma, injury prevention efforts have not been a primary research focus in Quito. Evaluation of all factors related to motor vehicle collisions, including social issues, economic costs, and driver and pedestrian education, is necessary. Of all the factors contributing to the large number of injuries due to motor vehicle collisions, poorly enforced traffic regulations may play the largest role. Additional regulations as well as modification and enforcement of existing traffic regulations would be an important first step in the attempt to reduce the disproportionate number of deaths due to motor vehicle-related trauma.

-Need for Changes in Availability of Emergency Medical Care

In addition to the need for the institution of measures designed to prevent injury in Quito, improvements are necessary in the way in which people are medically treated once they reach the hospital. There are three hospitals operated by the government within the city that will treat injury victims who have no insurance or demonstrable way of paying their own medical expenses. These hospital are severely under-staffed and poorly funded; patients routinely wait many hours in the emergency room before being seen, often with disastrous consequences for those severely ill or injured. Some of the other hospitals, such as Hospital Voz Andes, will treat indigent trauma victims initially, and, once stabilized, attempt to transfer them to the state-run hospital. Other hospitals, however, will not accept any patient who cannot demonstrate the ability to pay, regardless of the severity of the patient's condition. An example of this type of situation, told to the author while in Quito,

was the story of a young man, struck by a car in the city. He was apparently left lying on the side of the road for some time, severely injured, until picked up by a passerby and taken to the nearest hospital, a large private hospital within the city. The victim was unconscious and without any obvious means of identification or ability to pay for any services rendered. He was turned away and subsequently died while being transported to the nearest public hospital, located on the opposite side of the city. This scenario is not uncommon, although this particular example was often cited due to an ironic twist: the young man who died turned out to be the son of a physician at the private hospital to which he had first been taken. While this example illustrates the dire need for changes in the distribution and administration of health care resources, precise recommendations on how this should be done is outside the scope of this study.

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There are several problems inherent in our study. While the design of our initial splenic study was scientifically sound, we failed to realize the magnitude of the problems associated with collection of emergency transport data in Quito. The lack of organized emergency transport systems within the city prevented us from gathering the transport time data needed to precisely document the severity of the problem.

Second, the type of injury we chose to use for our study (injuries to the spleen) occurred only in a small percentage of the trauma population studied, resulting in a patient population too small to undergo statistical analysis. This could be rectified in two ways. One is to study a patient population with an injury that occurs more frequently in Quito, such as head injuries. In the same population of 521 trauma patients in which there were only five with splenic injuries, there were 162 patients with head injuries, perhaps providing, in retrospect, a better study population. The other option would be to enlarge the study to include all of the other hospitals within the city so as to provide a larger patient population base to use to screen for patients with splenic injuries. However, given the wide variability

in the record-keeping systems within the city's hospitals, this would undoubtedly prove to be very difficult.

Third, had we been able to prove that there was a significant difference between Quito and the United States in mortality due to splenic injury, such differences may have been due in part to differences in the predominant mechanisms of injury at the two locations, as well as differences in trauma transport availability. In retrospect, our analysis of the autopsy data has shown that there are major differences between the United States and Quito in the proportion of trauma deaths caused by each of the various injury mechanisms, particularly regarding the large number of pedestrian deaths in Quito. This difference in injury mechanism presents another variable that must be controlled in any future study of this problem.

Death statistics are the only readily available data that can be used in efforts to determine the overall impact of injury on the population of Quito. The autopsy data, while all-inclusive for the entire city, looks only at the trauma victims at the top of the "injury pyramid": those who died (Figure 3).

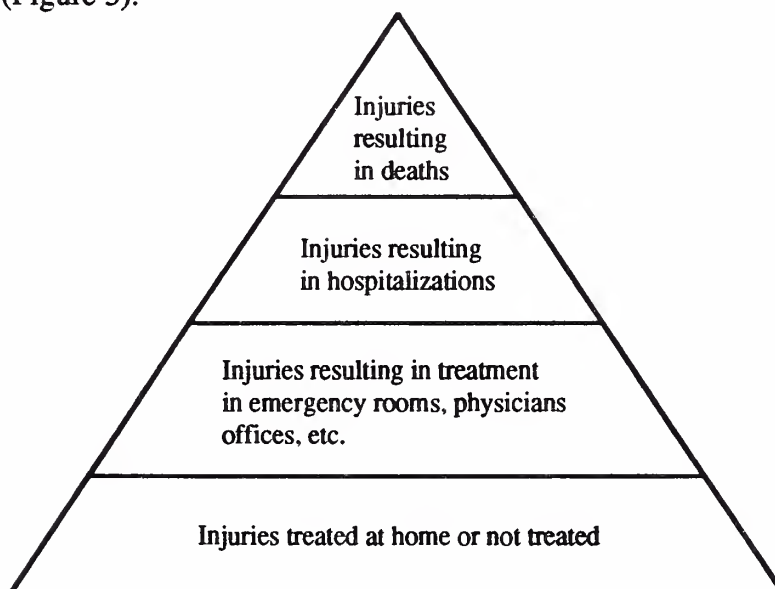


Figure 3. The Injury Pyramid.

Traumatic deaths, at the tip of the pyramid, represent only a fraction of the total number of people injured. One study of childhood injuries in the United States estimated that for each child under the age of 20 who died due to injury, there were 45 hospitalization and 1,300 visits to emergency rooms.²³ They also estimated that the number of injuries treated at home and in physician offices was probably twice that treated in emergency medical centers.²⁴

It is impossible to determine how these figures would compare with those of Ecuador and Quito, in particular. Given the problems associated with Quito's trauma treatment systems, it is highly likely that injuries resulting in death in Quito account for a significantly higher proportion of the total number of injury patients as compared to the United States. The inability to study this denominator in Quito (i.e. the number of people incurring any type of injury) illustrates both the magnitude of the problems associated with providing adequate medical care for trauma victims in Quito as well as the difficulties encountered when attempting to study this leading cause of death within the city.

Finally, our study has shown that adequate emergency transport systems are both obviously lacking and desperately needed in Quito. However, review of the autopsy data suggests that lack of pre-hospital treatment systems may not be the leading contributor to the excessive mortality caused by injury within the city. A large number of the trauma victims, particularly pedestrians, suffered very severe injuries (usually head injuries) that may have killed them regardless of the availability of emergency transport. Injury prevention may well be the only way to significantly reduce mortality in this cohort of severely injured patients. In addition to reducing the high cost of trauma in terms of human pain and suffering, injury prevention measures may well be easier and financially less expensive to implement than the development of extensive emergency transport systems. Only 4% of Ecuador's GNP (Gross National Product) is applied to health care; lack of

financial resources is often a severely limiting factor in attempts to provide adequate medical services within the country. While injury prevention measures and trauma transport systems are both desperately needed in Quito, the socio-economic situation in Ecuador may well dictate that initial attempts at reducing excessive trauma mortality be focused on efforts to prevent injury. Considering the high number of fatalities due to motor vehicle-related trauma, efforts to improve traffic regulations and make low-cost environmental changes may well yield the best results for each injury prevention-dollar invested.

While much of the data from our study may seem very basic, to our knowledge this is the first time many of these trauma statistics have been studied in Ecuador. Description and identification is the first necessary step in solving any type of problem; this study helps to identify certain factors contributing to trauma becoming the number one cause of death in Quito. The Ministry of Public Health in Quito has expressed a deep interest in this research project, and has requested that the principle author return to Quito to report our findings to the Ecuadorian government. They hope to use our data in support of proposed legislative changes regarding motor vehicle regulations, traffic laws, etc.. It is our hope that their efforts are successful, and that the data from our study helps to reduce the number of trauma deaths within Quito in the very near future.

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